PART 1 - GENERAL

1. DESIGN OF HELICAL PILE FOUNDATIONS

1. The geotechnical design of helical pile foundations shall conform to the latest editions of the National Building Code, Canadian Foundation Engineering Manual (CFEM) and any local applicable building codes.
2. The structural design of helical piles and pile caps shall conform to the latest editions of CSA-S16 for the design of steel structures and CSA-A23.3 for the design of concrete as well as any applicable local, national, or international codes and standards.
3. Helical pile design shall take into consideration the following, if provided:

Loading Information
- Foundation design loads – SLS (Serviceability Limit State)
- Foundation design loads – ULS (Ultimate Limit State)

Geotechnical Resistance Factor (GRF)
- Unless specified otherwise, based on the Canadian Foundation Engineering Manual 2006 (CFEM), Section 8.6, the following GRF are recommended for helical pile foundation design:
  GRF for compression is 0.4 (without static pile load testing)
  GRF for compression is 0.6 (with static pile load testing)
  GRF for uplift/tension is 0.3.

4. A helical pile design engineer should have adequate foundation design experience and geotechnical engineering knowledge
5. The helical pile foundation design should be based on clearly specified methodology and design process. All calculation formulas and details, including assumptions, shall be made available upon request for review.

Note: Helical pile design shall be in accordance with fundamental engineering principles and shall not be dependent of the sole use of empirical torque factor (KT) unless supported by CCMC documentation.

2. SUBMITTALS

1. Project specific drawings for initial review (IFR) shall be submitted to the Client.
2. Project specific construction drawings (IFC) sealed by a registered engineer in the province of Ontario shall

be submitted to the Client. These drawings shall include:

a. Quantity, type and layout of piles
b. Pile design loads
c. Size of shafts and helices, and configuration of these elements
d. Materials and procedures to be used in fabrication
e. Minimum and maximum anticipated torques during installation
f. Pile cap configuration, materials and connection details
g. Weld sizes and standards
h. Acceptable installation tolerances
i. Load testing and inspection plan
j. Design summary

3. HELICAL PILE MATERIALS

1. Only new materials shall be used for the fabrication of helical piles.

2. Minimum requirements for steel pipe used for helical piles are as follows unless noted otherwise.

All helical piles shall be fabricated with welded or seamless steel pipe that conforms to any of the following specifications or an equivalent.

Pipe Grade	Yield Strength	Tensile Strength
ASTM A252 –	(35 ksi) 240 MPa	(60 ksi) 414 MPa
ASTM A252 –	(45 ksi) 310 MPa	(66 ksi) 455 MPa
ASTM A500 –	(42 ksi) 290 MPa	(58 ksi) 400 MPa
ASTM A500 –	(46 ksi) 317 MPa	(62 ksi) 428 MPa
API 5L – X46	(46 ksi) 317 MPa	(63 ksi) 434 MPa

Commonly available pipe sizes used for helical piles are shown below. Additional pipe diameters and wall thicknesses are also available and may be selected based on project requirements.

Pipe Diameter	Standard Wall Thickness inches
2.375” (60)	0.217” (5.51)
2.875” (73)	0.217” (5.51)
3.500” (89)	0.250” (6.35)
4.500” (114)	0.250” (6.35)
5.500” (140)	0.304” (7.72)
6.625” (168)	0.280” (7.11)
7.000” (179)	0.317” (8.05)

8.625” (219)	0.322” (8.18)
10.750” (273)	0.365” (9.27)
12.750” (324)	0.375” (9.53)
16.000” (406)	0.375” (9.53)
20.000” (508)	0.375” (9.53)

- Note: Square shaft sections are not recommended unless soil voiding during installation can confidently be remediated by pressure grouting.
- Note: Gravity fed grout placement is not recommended.

3. Steel Plate for Helix and Pile Cap Material: Material grades shall conform to CSA-G40.21 “Structural Quality Steels” or per Client specifications. Examples of common yield and tensile strengths are listed below and shall be selected to meet the structural design requirements

Grade	Yield Strength	Tensile Strength
ASTM A36	(36 ksi) 250 MPa	(60 ksi) 414 MPa
CSA 44W	(44 ksi) 300 MPa	(60 ksi) 414 MPa
CSA 50W &	(50 ksi) 350 MPa	(65 ksi) 450 MPa

4. All helical pile shaft and helices shall be hot-dipped galvanized.

4. WELDING

1. The latest revisions of the following standard specifications (or equivalents) shall apply for the welding and fabrication of helical piles for structural applications:
   a. CSA W47.1 Certification of Companies for Fusion Welding of Steel
   b. CSA W59 Welded Steel Construction (Metal Arc Welding)
   c. CSA W48 Filler Metals and Allied Materials for Metal Arc welding
2. All welding procedure specifications (WPS), quality and inspection requirements shall conform to CSA W59. All WPS used shall be approved by the Canadian Welding Bureau (or equivalent certifying organization).
3. All inspection and testing reports and non-conformance reports shall be maintained by the fabricator and may be made available to the Client upon request.
4. Electrode Ultimate Tensile Strength = 485 MPa (70 ksi) or

higher.

5. Non-destructive Evaluation (NDE) may be requested by the Client/Owner and shall be specified in the contract terms.

5. HELICAL PILE FABRICATION

1. All helical pile fabrication shall be performed by a facility that complies with ISO 9001 requirements.
2. Helical pile manufacturer shall hold a current Evaluation Report completed by Canadian Construction Materials Center (CCMC)
3. Helix shall be welded to the pipe section using a continuous fillet weld on both sides of the helix to pipe connection.
4. Welding procedures and welder qualifications shall conform to CSA W47.1 and CSA W59. Welding electrodes (for either stick welding or wire feed welding) shall confirm to CSA W48.
5. Helical plate should have a minimum thickness of 9.5mm (3/8”).
6. Unless otherwise specified, all piles shall be open ended and the pile tip shall be cut at 45°.
7. The leading edge of the first helix shall be sharpened to minimize soil disturbance during installation.
8. Helices shall be mechanically formed by suitable means to ensure “True-Pitch” shape is formed. The helix must be formed such that the surface of the helix remains perpendicular to the pipe shaft (within ±2°) along the entire distance around the pipe shaft. This is critical to ensure the helix cuts cleanly through the soil with minimal soil disturbance and to provide representative torque measurements to achieve the specified pile capacities.
9. When multiple helices are welded on a pile, the spacing of helices shall be such that the distance from the lead of the lower helix to the lead of the upper helix is a whole number multiple of the helix pitch. This is critical to ensure that the upper helices follow exactly in the path of the first helix in the soil, again to minimize soil disturbance and to obtain acceptable correlation between torque measurement and pile capacities.
10. All edges on piles shall be ground and clear of slag, burrs, or sharp edges.
11. Hot-Dipped Galvanizing shall be completed by a qualified supplier complying with the latest ASTM A123

standard. The pile shall be galvanized inside and out and free from any galvanizing slag.

12. Any pipe splice welding shall be full strength complete penetration groove welds.

6. HELICAL PILE INSTALLATION

1. Prior to helical pile installation, all site-specific permits must be obtained. All underground utilities must be located, marked and identified by the proper authorities. Responsibility for permits and locates will be determined by contract terms.
2. The installation of helical piles shall be performed by experienced and well-trained installation personnel with a minimum 5 years helical pile installation experience of similar size and scope. Supporting documentation of such experience shall be provided.
3. Unless otherwise specified by the Design Engineer:
    a. All piles shall be installed to design embedment depths as specified in the pile schedule drawings or specifications,
    b. The piles shall be installed achieving the design torque values as specified in the pile schedule drawings or specifications.
    c. All piles shall be installed to ensure the uppermost helix is below the maximum frost penetration depth as per the design drawings or specifications.
4. Installation Equipment
    a. Suitable installation equipment should be selected to provide sufficient reach, lifting and torque capacities for helical pile installation. Recommended torque capacity should exceed design torque by 20 percent.
    b. The installation equipment should be well maintained with applicable certifications performed on a regular basis.
    c. Provide torque monitoring device as part of the installation unit or as a separate in- line device capable of recording torque or drive head hydraulic operating pressure. In the case of drive head hydraulic pressure being used for torque monitoring, the conversion factors for the specific drive head shall be provided.

d. Annual calibration certificates for torque monitoring devices and/or hydraulic pressure transducers shall be provided by the contractor prior to start of installation to

ensure accurate correlation between hydraulic pressure and applied torque.

e. Torque shall be monitored continuously during the entire installation.

5. Helical Pile Placement

a. If required, survey professionals shall mark the location for the center of the pile using a flagged pin or nail as per specified locations in the installation IFC drawings.

b. Position helical pile as indicated on drawings. Place the center of the pile on the pinned location. Establish the proper angular alignment at start of installation.

c. Install helical piles in a smooth and continuous manner. Apply downward pressure to aid in the advancement of the pile into the ground.

d. Unless noted otherwise, vertical pile cut-off tolerance should be within ±6 mm of cut-off elevation specified by the client.

e. The placement of helical piles shall be considered satisfactory providing the following conditions have been met:

i. At the cut-off elevation of the pile, the horizontal location of the center of the pile (northing and easting) is located within +/-50mm of the position specified on the drawing.

ii. Piles are within +/-2 degrees inclination from the vertical or their intended batter angle.

iii. The piles, as placed, have not been structurally damaged.

iv. Structural changes or repairs to the installed pile due to improper placement of piles shall be made only as directed by the Design Engineer.

6. Helical Pile Extensions

a. A pile extension may be required when design torque cannot be achieved with a single length of pile.

b. Field Welded Extension: Design Engineer shall specify the field weld requirements and an approved Weld Procedure Specification shall be utilized for the welded connection of the extension to the lead pile in the ground. The welding procedures shall conform to W47.1 and W59.

c. Field Bolted Extension Connection: A bolted connection may be used if the design has been analyzed from both structural and geotechnical engineering to meet the loading requirements for the pile. Considerations must include the ability to withstand both the installation torque and the service loads; analysis of the "slack" in the bolted connection that may result in movement of the joint in uplift or lateral forces and confirmation that performance specifications will be met.

7. LOAD TESTING

1. If pre-production and/or production load testing of piles is required, testing shall be according to the following ASTM Standards:

   Compression: ASTM D1143
   Tension: ASTM D3689
   Lateral: ASTM D3966

8. HELICAL PILE ENGINEERING APPROVAL

1. Pile design embedment depth and design torque may be revised when unexpected soil conditions are encountered as follows:
   a. At pile locations where harder soil conditions (higher than expected installation torque) are encountered at shallow depths, the design embedment may be reduced based on design engineer approval.
   b. At pile locations where weaker soil conditions (lower than expected installation torque) are encountered, the design embedment may be increased based on design engineer approval.
2. Complete pile installation records shall be submitted to the Design Engineer for review and approval at each pile location. The pile record should include, but not limited to, the following aspects:

   a. Installation date and time
   b. Installation personnel
   c. Installation equipment Identification Number
   d. Pile location
   e. Pile Identification Number
   f. Pile extension (if any) Identification Number
   g. Installed pile length
   h. Installed pile embedment depth

i. Installed pile final torque
j. Installed pile batter angle
k. Installed pile inclination
l. Cut-off elevation
m. Distance from top of pile to ground surface
n. Relevant field notes and observations

3. The installation torque shall be recorded continuously during installation with specific attention given to the last 1500mm of the pile installation and the final installed depth. These torque profiles will be used by the Design Engineer to approve each pile installation per design requirements.

4. Any deviation from the installation specifications shall be reported to the Design Engineer immediately for evaluation, design revision, and approval. These deviations could be listed as following:

   a. Field observations indicating discrepancies between the design soil profile and the actual in-situ conditions
   b. Lack of pile advancement or obstructions
   c. Sudden changes in installation torque

5. The installed pile horizontal location (northing and easting) and the pile cut-off elevation of each pile should be reviewed and approved by the Design Engineer. For out-of- tolerance piles, specific repair solution should be directed by the Design Engineer and approved by the Client's engineer prior to construction.

9. HELICAL PILE RECORDS

1. Fabrication records shall be completed for each pile and stored for both manufacturing and Quality Control and Assurance purposes. The pile fabrication record should include, but not limited to, the following aspects:

   a. Pile Shop drawings
   b. Pile Identification Number
   c. Pile part number
   d. Pipe heat number
   e. Helices heat numbers
   f. Welding personnel
   g. Manufacturing date and time
   h. CWB inspection date and time
   i. Inspector Identification Number
   j. Welding inspection procedure

2. During installation, the following information shall be recorded for each helical pile installation: pile identification number (serial number), pile geometric

description, installation location, final torque and final embedment depth. This information will be recorded in a pile installation summary report.

3. A helical pile installation summary report for all piles installed shall be provided by the installation contractor to the Client/Owner at the completion of the project. This report shall be reviewed, approved and stamped by the Design Engineer.

4. If required, final as-built survey locations shall be recorded by survey professionals and then reviewed and approved by the Design Engineer to confirm all piles have been installed within specified location tolerances per the installation IFC drawings and/or any approved changes.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

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